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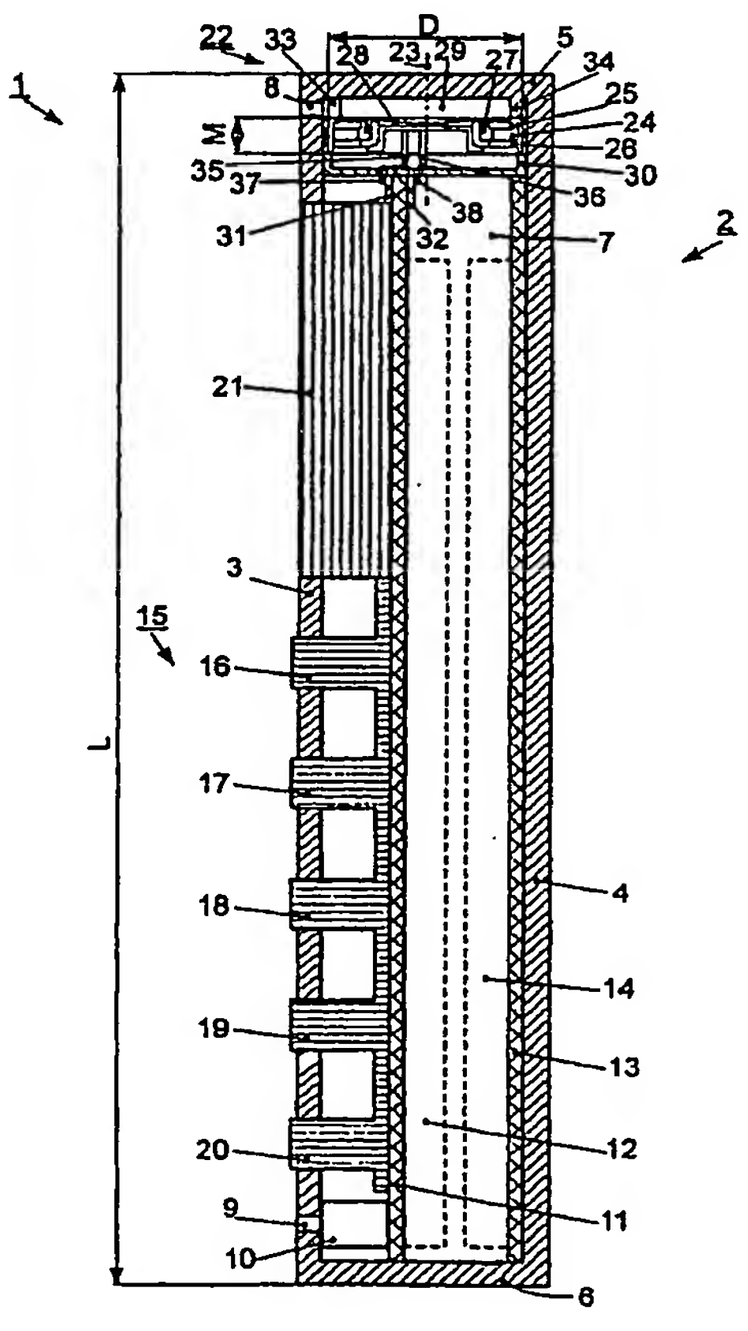
(54) Title: MOBILE TELEPHONE WITH A LOUDSPEAKER

(57) Abstract

In a mobile telephone (1) with a housing (2) that has a housing wall (3) with at least one sound opening (8, 9) and with a loudspeaker (22) arranged in the housing (2) adjacent to the housing wall (3), which loudspeaker has a loudspeaker axis (23) and whose dimension (D) transverse to the loudspeaker axis (23) is larger than its dimension (M) along the loudspeaker axis (23), where the loudspeaker (22) comprises sound generation means (27, 28) by which sound can be delivered to the at least one sound opening (8) via a forespace (29), the loudspeaker (22) is arranged inside the housing (2) in such a way that the loudspeaker axis (23) in essence runs parallel with the housing wall (3) and sound–conducting means (5, 30, 33, 34) are provided by which sound generated by the sound generation means (27, 28) can be conducted from the forespace (29) to the at least one sound opening (8).



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Mobile telephone with a loudspeaker.

The invention relates to a mobile telephone with a housing that has a housing wall with at least one sound opening and with a loudspeaker arranged in the housing adjacent to the housing wall, which loudspeaker has a loudspeaker axis and whose dimension transverse to the loudspeaker axis is larger than its dimension along the loudspeaker axis, while the loudspeaker has sound generation means by which sound can be delivered to the at least one sound opening via a forespace.

Such a mobile telephone of the type indicated above in the opening paragraph has, for example, been sold by the applicants under the name of "Spark™ GSM". The known mobile telephone has a housing, which accommodates a loudspeaker, a microphone and processing means for processing an electric loudspeaker signal and an electric microphone signal. For this purpose, the loudspeaker and the microphone are connected to the processing means in an electroconductive manner. The processing means are further arranged for transmitting a processed microphone signal and for receiving a loudspeaker signal.

The housing comprises a housing wall with a plurality of sound openings through which, during a telephone call with the mobile telephone, the loudspeaker can deliver sound to a user's ear pressed against the housing wall of the mobile telephone.

The loudspeaker has a circular form and has a diameter D and a thickness M, while the diameter D is considerably larger than the thickness M. The loudspeaker is attached to the inside of the housing wall while the loudspeaker having the thickness M sticks into the inside of the housing and takes up a surface A of $A = (D/2)^2 * \pi$ of the housing wall.

The loudspeaker includes sound generation means formed by a coil and a membrane. In the operative loudspeaker the coil is movable along a loudspeaker axis in accordance with the loudspeaker signal applied thereto, the loudspeaker axis being perpendicular to the housing wall. The coil is connected to the membrane of the loudspeaker for generating sound. The membrane of the loudspeaker can deliver sound to a forespace from which sound can be delivered by the mobile telephone through the sound openings of the housing wall.

The mobile telephone has a longitudinal shape, the loudspeaker being arranged on one end and the microphone on the other end in the housing wall of the mobile telephone.

In the housing wall surface between the loudspeaker and the microphone, there are further openings to accommodate a display and a keypad that includes a plurality of keys.

In the known mobile telephone it has appeared that the longitudinal shape is too large and a new improved mobile telephone is to have an even smaller longitudinal shape. However, this poses the problem, when the size of the longitudinal shape of the known mobile telephone is further reduced, that the housing wall surface that is left between the loudspeaker and the microphone in the new mobile telephone is smaller. Since the keys of the mobile telephone cannot be made any smaller, without simultaneously considerably reducing the ease of operation, and the dimensions of the loudspeaker can no longer be reduced, in essence, the display should be made smaller which, however, also implies a disadvantage.

It is an object of the invention to provide a mobile telephone that has a smaller longitudinal shape, without reducing the surface of the housing wall that has at least one sound opening between the loudspeaker and the microphone. With the mobile telephone of the type defined in the opening paragraph, this object is achieved in that the loudspeaker is arranged in the housing in such a way that the loudspeaker axis runs, in essence, parallel with the housing wall and in that sound-conducting means are provided by which sound generated by the sound generation means can be led from the forespace to the at least one sound opening.

As a result, in essence, only one surface A of A = D*M of the housing wall is taken into consideration, which in normal loudspeakers is considerably smaller than the surface A of $A = (D/2)^2 * \pi$, so that more surfaces of the housing wall between the loudspeaker and the microphone are available for a keypad and a display. Furthermore, the part of the oblong body of the mobile telephone taken up by the loudspeaker is reduced from the dimension of the diameter D to the dimension of the thickness M of the loudspeaker.

In a mobile telephone as claimed in claim 1 it has been found advantageous to provide the measures as claimed in claim 2. They provide the advantage that the sound-conducting means, and thus a mobile telephone with sound-conducting means, may be manufactured in a highly cost-effective manner.

With a mobile telephone as claimed in claim 1 it has been found advantageous to provide the measures as claimed in claim 3. Since the dimension crosswise to the loudspeaker axis (diameter D) is generally considerably larger than the dimension parallel with the loudspeaker axis (thickness M), in a loudspeaker formed by an electrodynamic transducer, the measures as claimed in claim 1 have been found highly advantageous.

In a mobile telephone as claimed in claim 1 it has been found advantageous to provide the measures as claimed in claim 4. In a mobile telephone comprising a keypad and/or a display respectively, which may be provided on the remaining surface of the housing wall between the loudspeaker and the microphone, it is extremely important to arrange the loudspeaker as claimed in claim 1 in a surface-saving manner.

In a mobile telephone as claimed in claim 1 it has been found advantageous to provide the measures as claimed in claim 5. When such a built-in element is provided, one type of loudspeaker can be adapted to the mechanical and electrical requirements of numerous different mobile telephones, which is advantageous.

With a mobile telephone as claimed in claim 5 it has been found advantageous to provide the measures as claimed in claim 6. This offers the advantage that the sound-conducting means and a mobile telephone including sound-conducting means can be realized in a highly cost-effective manner.

The aspects defined above and further aspects of the invention follow from the example of embodiment to be described hereinafter and are further explained with reference to this example of embodiment.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiment(s) described hereinafter.

In the drawings:

Fig. 1 shows a mobile telephone in a sectional view.

The Fig. 1 shows a mobile telephone 1 in a sectional view. The mobile telephone 1 comprises a housing 2 with a front wall 3, a back wall 4, a top wall 5, a bottom wall 6 and two side walls, only one side wall 7 being represented in the Figure due to the sectional view. A length L of the housing 2 indicates the longitudinal shape of the mobile telephone 1.

The front wall 3 has a first sound opening 8 and a second sound opening 9 which allow sound to pass from the housing to the outside or from the outside into the housing respectively, through the front wall 3. A microphone 10 is arranged inside the housing 2 near to the front wall 3 at the second sound opening 9. A sound produced by a user of the mobile telephone 1 during a telephone call can be delivered to the microphone 10 through the second sound opening 9. The microphone 10 can produce an electric microphone signal that corresponds to the sound supplied to the microphone 10.

The mobile telephone 1 further includes processing means for processing a loudspeaker signal and the microphone signal. The processing means are formed by a first printed circuit board 11 and diagrammatically shown first electronic components 12 arranged on the first printed circuit board 11, and a second printed circuit board 13 and diagrammatically shown second electronic components 14 arranged on the second printed circuit board 13. The processing means include a telephone number memory, in which telephone numbers and associated names can be stored. The processing means are further arranged for transmitting a processed microphone signal and for receiving a loudspeaker signal, as this is generally known.

The mobile telephone 1 further includes a keypad 15 with a first key 16, a second key 17, a third key 18, a fourth key 19 and a fifth key 20. Further keys of the keypad 15 are not shown in the Fig. 1 due to the sectional view of the mobile telephone 1. The keys of the keypad 15 are connected in an electroconductive manner to the first printed circuit board 11 in a manner not further shown in Fig. 1. By means of the keys of the keypad 15, a user of the mobile telephone 1 is enabled to activate and deactivate different functions of the mobile telephone 1, as this is generally known.

The mobile telephone 1 further includes a display 21 for displaying telephone numbers and names stored in the telephone number memory and for displaying modes of operation of the mobile telephone 1. The display 21 is electroconductively connected to the first printed circuit board 11 in a manner not further shown in the Fig. 1.

A loudspeaker 22, which is formed by an electrodynamic transducer and which has a loudspeaker axis 23, is accommodated in the housing 2 of the mobile telephone adjacent to the front wall 3. The loudspeaker 22 has a circular form and a diameter D and a thickness M, the diameter D being larger than the thickness M.

The loudspeaker 22 includes a permanent magnet 24 whose magnetic flux runs through a top plate 25 and a core plate 26 which are both magnetically conducting via an air gap in a magnetic circuit. In the air gap of the magnetic circuit is inserted a coil 27 that is movably arranged relative to the permanent magnet 24, the top plate 25 and the core plate 26. The coil 27 is struck to a membrane 28. The coil 27 and the membrane 28 then form sound generation means of the loudspeaker 22, by which sound can be delivered to the first sound opening 8 via a forespace 29.

The loudspeaker 22 is now arranged in the housing 2 in such a way that the loudspeaker axis 23 runs parallel with the front wall 3 of the housing 2. The top wall 5 of the

housing 2 then forms part of sound-conducting means by which sound generated by the sound generation means is conducted from the forespace 29 to the first sound opening 8.

This provides the advantage that the loudspeaker 22, in essence, uses only a surface A of A = D*M of the front wall 3, so that more surface of the front wall 3 between the loudspeaker 22 and the microphone 10 is available for the keypad 15 and the display 21. Furthermore, the part of the length L of the mobile telephone 1 used by the loudspeaker 22 is advantageously reduced from the dimension of the diameter D to the dimension of the thickness M of the loudspeaker 22. This is especially advantageous, because the diameter D of an electrodynamic transducer, such as the loudspeaker 22, is larger than the thickness M of the loudspeaker 22 and, as a result, the length L of the mobile telephone 1 can, in essence, be reduced by the dimension (D-M), without changes to the dimensions of the display 21 or the keypad 25.

Furthermore, it is especially advantageous that the top wall 5 of the housing 2 forms part of the sound-conducting means and, as a result, separate sound-conducting means may be avoided. This obtains highly cost-effective sound-conducting means.

At this point, the mobile telephone 1 includes a built-in component 30 in which the loudspeaker 22 can be inserted and via which the loudspeaker 22 can be mechanically connected to the housing 2 and electroconductively connected to the first printed circuit board 11 of the processing means. The loudspeaker 22 can be mechanically snapped into built-in component 30 in a manner not further shown in Fig. 1. A first stopper 31 and a second stopper 32 of the built-in component 30 can be shifted onto the first printed circuit board 11 for realizing a mechanical connection.

Three snap-on pivots of the housing 2 keep the loudspeaker 22 in its position on the first printed circuit board 11 shifted by the first and second stoppers, only a first snap-on pivot 33 and a second snap-on pivot 34 being shown due to the sectional view. Furthermore, the snap-on pivots hold the loudspeaker 22 in a position at a certain distance from the top wall 5 and then guarantee the foreroom 29.

The loudspeaker 22 has a first coil contact 35 and a second coil contact 36, which are formed, by spring contacts. The coil contacts form an electroconducting link between the coil 27 and the first built-in contact 37 and a second built-in contact 38. The first built-in contact 37 and the second built-in contact 38 are provided for electrically connecting the coil 27 to the first printed circuit board 11.

The insertion of the loudspeaker 22 into the built-in component 30, which is adapted to the requirements of the mobile telephone 1 for mechanical and electrical contacts,

offers the advantage that the loudspeaker 22 can be inserted into many mobile telephones. As a result, the loudspeaker 22 can be manufactured in a cost-effective way in large amounts for a large number of mobile telephones, so that also the mobile telephones can be manufactured in a cost-effective way.

The built-in component 30, with the front wall 3, the back wall 4 and the side walls of the mobile telephone 1, forms a cavity and prevents a sound delivered by the sound generation means in the forespace 29 being propagated to the rest of the housing 2. As a result, part of the sound-conducting means is advantageously formed by the built-in component 30, so that separate sound-conducting means may be omitted.

It may be observed that, for a better emission of certain frequency ranges of a sound produced by the loudspeaker 22 it may be advantageous for the built-in component 30 not to form a sealed cavity with the front wall 3, the back wall 4 and the side walls of the mobile telephone 1, and for part of the sound to penetrate into the rest of the housing 2. When such certain frequency ranges can be produced very well by the mobile telephone, a built-in component can have a suitable shape for this purpose.

It may be observed that a loudspeaker need not be immediately adjacent to the front wall, whereas in that case sound-conducting means for conducting a sound produced by the loudspeaker are to be laid out to a sound opening over a larger distance.

It may be observed that also a top wall, a back wall and side walls of a mobile telephone may have sound openings through which sound generated by the sound generation means can pass.

It may be observed that a loudspeaker with a loudspeaker axis can be arranged inside a housing of a mobile telephone, for example, in such a way that the loudspeaker axis has an angle α of $\alpha = 45°$ to the front wall of the housing. By determining the angle α, the thickness and longitudinal shape of the housing of the mobile telephone may be optimized. Many further advantageous angles α will be recognized by the expert.

It may be observed that the angle α may also be $\alpha = 90°$, in which case the forespace is then formed between the membrane of the loudspeaker and the back wall of the housing, and sound-conducting means conduct a sound generated by the loudspeaker to at least one sound opening of the front wall of the housing.

CLAIMS:

1. A mobile telephone (1) with a housing (2) that has a housing wall (3) with at least one sound opening (8, 9) and with a loudspeaker (22) arranged in the housing (2) adjacent to the housing wall (3), which loudspeaker has a loudspeaker axis (23) and whose dimension (D) transverse to the loudspeaker axis (23) is larger than the dimension (M) along the loudspeaker axis (23), while the loudspeaker (22) has sound generation means (27, 28) by which sound can be delivered to the at least one sound opening (8) via a forespace (29), characterized in that the loudspeaker (22) is arranged in the housing (2) in such a way that the loudspeaker axis (23) runs, in essence, parallel with the housing wall (3) and in that sound-conducting means (5, 30, 33, 34) are provided by which sound generated by the sound generation means (27, 28) can be led from the forespace (29) to the at least one sound opening (8).

2. A mobile telephone as claimed in claim 1, characterized in that the housing (2) of the mobile telephone (1) forms at least part of the sound-conducting means (5, 30, 33, 34).

3. A mobile telephone (1) as claimed in claim 1, characterized in that the loudspeaker (22) is formed by an electrodynamic transducer.

4. A mobile telephone (1) as claimed in claim 1, characterized in that the housing wall (3) has further openings for accommodating a keypad (15) comprising at least one key (16, 17, 18, 19, 20) and/or respectively for accommodating a display (21).

5. A mobile telephone (1) as claimed in claim 1, characterized in that processing means (11, 12, 13, 14) are provided for processing a loudspeaker signal that can be fed to the loudspeaker (22) and in that a built-in component (30, 31, 32, 37, 38) is provided in which the loudspeaker (22) can be installed and via which the loudspeaker (22) can be mechanically connected to the housing (2) and electrically connected to the processing means (11, 12, 13, 14).

6. A mobile telephone (1) as claimed in claim 5, characterized in that the built-in component (30, 31, 32, 37, 38) forms at least part of the sound-conducting means (5, 30, 33, 34).

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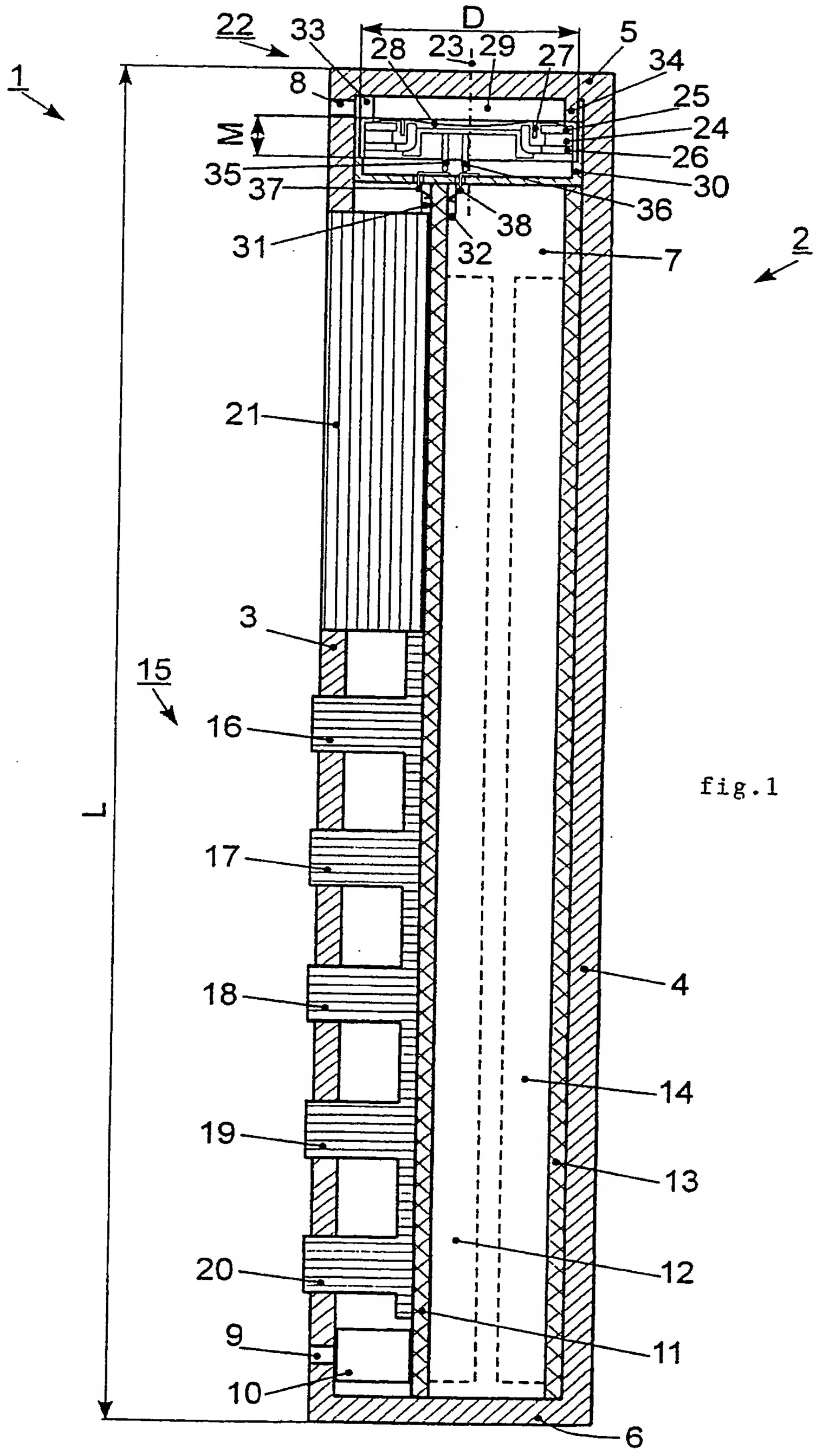
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INTERNATIONAL SEARCH REPORT

In ational Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04M1/03 H04M1/02

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 20659 A (ERICSSON GE MOBILE INC) 14 May 1998 (1998-05-14) page 2, line 10-14 page 5, line 4-11; figure 2 page 9, line 15 -page 10, line 17; figures 6,7	1,4
A	---	2,5
A	GB 2 310 559 A (NOKIA MOBILE PHONES LTD) 27 August 1997 (1997-08-27) abstract; figures 1,4 claim 2	1-4
A	---	
A	US 2 405 543 A (TELEFON AB L M ERICSSON) 6 August 1946 (1946-08-06) column 3, line 24-51; figure 3 column 4, line 9-12	1-3

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 February 2000	01/03/2000

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category '	Citation of document, with indication.where appropnate, of the relevant passages	Relevant to claim No.
A	US 3 748 583 A (ING D ET AL) 24 July 1973 (1973-07-24) column 1; figures 1,2,4,5	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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